# CHAPTER III.2. COST OF LOW BIRTH WEIGHT

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# CHAPTER III.2. COST OF LOW BIRTH WEIGHT

## III.2.A Background

This chapter contains a discussion of the methods used and the results of estimating the direct medical costs incurred by individuals with low birth weight (LBW). It does not include information on elements such as indirect medical costs, pain and suffering, lost time of unpaid caregivers, etc. The reader is referred to Chapter I.1 for a discussion of the cost estimation methods and cost elements that are relevant to all benefits estimates. Chapter III.1 contains information regarding the causes and special characteristics of developmental illnesses and disabilities, as well as environmental agents linked to these disorders.

*Link to Chapters I.1 and III.1*

Low birth weight is a serious medical condition that occurs in approximately seven percent of all infants born in the United States (Oski, 1993). It is associated with multiple adverse effects in numerous organ systems and carries a much higher risk of death than normal birth weight. Consequently, considerable medical resources are devoted to the treatment of LBW infants and the medical expenditures on these infants is estimated to be $5 billion per year (Lewit et al.,1995). This chapter contains a detailed estimate of the medical and related costs associated with LBW for children through age ten and limited additional information for older individuals. Data regarding special education and aggregate costs are included due to their availability, although they are not in the usual scope of this handbook. The chapter also contains a brief discussion of the medical science related to LBW.

The costs presented in this chapter were current in the year the chapter was written. They can be updated using inflation factors accessible by clicking on the sidebar at left.

*Link to inflation factors*

### III.2.A.1 Description

LBW babies are defined as having a weight less than 2,500 grams (5.5 lbs), and very low birth weight infants weight is defined as a birth weight under 1,500 grams (3.3 lbs). "Low birth weight results when infants are born prematurely or grew too slowly in utero, or a combination of the two" (Paneth, 1995). These children may be 1) full-term infants with intrauterine growth retardation (IUGR, see below); 2) born prematurely,

with IUGR; or 3) appropriate for their gestational age, but with LBW due to their prematurity. Regarding the full-term infants, IUGR is considered a "final common pathway by which genetic and environmental influences result in low birth weight for gestational age" infants (Oski, 1994). These are infants that are born after a normal duration pregnancy, but have retarded growth, and are born smaller and in a more immature condition than normal infants.

There are varying degrees of severity of LBW. Infants who are 1,501 to 2,500 grams are considered moderately low birth weight and comprise 82 percent of LBW infants. At 1,001 to 1,500 grams they are very low birth weight infants; this occurs among 12 percent of LBW infants. Six percent of LBW infants weigh 1,000 grams or less at birth are designated as extremely low birth weight children (Oski, 1993).

Regardless of the child's status with respect to pregnancy duration, there are serious consequences associated with low birth weight in many children. More than three-quarters of all infant deaths have been attributed to LBW (Paneth, 1995). When compared to normal-weight infants, moderate, very low, and extremely low birth weight infants have a risk of death that is 40 times, 200 times, and 600 times higher, respectively, than the risk of death among normal-weight infants. Children who survive often face multiple medical disorders arising from LBW (Oski, 1993).

In LBW infants, the basic mechanisms for survival outside the womb are often lacking. Premature LBW infants typically have very limited body fat (energy stores), inability to maintain an acceptable body temperature, and less available energy resources that are required for vital cellular processes, including protein synthesis and other basic physiological processes. Organ systems may be functionally immature, including the respiratory system. An inability to maintain fluid balance leads to patent ductus arteriosus in 15 to 35 percent of very LBW and extremely LBW infants. This condition is associated with myocardial stress, pulmonary congestion, progressive heart failure, hepatic congestion, and a constellation of progressively serious disorders. Intracranial hemorrhage occurs in 40 to 50 percent of LBW infants and is a major cause of morbidity and mortality (Oski, 1993).

LBW is associated with other developmental abnormalities including delayed cognitive development and other central nervous system (CNS) disabilities. For example, approximately 20 percent of infants born at weights between 500 and 1500 grams have brain injury (Hack et al., 1994). These acute problems often result in chronic medical conditions in the LBW child. The disorders and diseases may occur in any organ system, but are often seen in the gastrointestinal system (necrotizing enterocolitis), respiratory system (bronchopulmonary dysplasia), the nervous system, and the eyes (retinopathy of prematurity) (Oski, 1993).

Many babies with birth weights as low as 750 grams (1 pound, 10 ounces) are surviving due to technology available in neonatal intensive care units (Hack et al., 1994). This technology is expensive. The medical costs associated with LBW have been estimated to be $5.4 billion per year (incremental direct costs among children ages birth to 15 years in 1988) (Lewit, et al., 1995). This value does not include the costs of long term care, special services, and special education, which are estimated to add an additional $500 million per year. The medical expenditures for LBW children is approximately one-tenth of the total expenditure for health care for all children (Lewit et al., 1995).

### III.2.A.2 Concurrent Effects

Concurrent effects are those that often occur with, but are not necessarily caused by, the disease or disorder under discussion. LBW is a condition that causes many adverse effects, and also occurs concurrently with certain types of conditions and diseases. It is not always possible to determine whether LBW was a causative agent for a specific medical condition, or whether the disorders occurred independently, but in tandem, perhaps arising from the same cause. Often the factors or agents responsible for LBW are linked to concurrent disorders.

LBW has been linked with most developmental defects. As noted above, children with low birth weight are often afflicted with severe brain damage, cerebral palsy, and disorders of multiple organs (e.g., lung and liver disease, learning disabilities, asthma, and attention disorders). Children may be born with low birth weight because of birth defects that cause growth retardation. Alternatively, children may have a number of birth defects because their birth weight and development are considerably retarded. Finally, as noted above, the low weight at birth may be simply concurrent with other birth defects, when the factors that lead to low birth weight also cause other birth defects (Oski, 1993).

Although long-term disabilities and illnesses may be associated with LBW, the medical costs associated with these effects are not discussed individually in this chapter, but are included in the final cost estimates. The estimated costs in this handbook for LBW incorporate *all* costs of medical treatment that exceeded those for a non-LBW child. Consequently, these incremental medical costs include the costs of treating concurrent effects, are included in the final incremental cost estimate.

Many of the long-terms effects are discussed in subsequent chapters (e.g., cerebral palsy) because these effects also occur independently of LBW. The occurrence and costs estimates presented in this chapter are based on the incidence in the overall LBW population. If an agent is known to cause LBW plus another disorder (e.g., cerebral palsy) at a higher rate than is usually found in the LBW population as a result of environmental agents

than is typically observed with LBW in the general population, it would be necessary to add costs associated with the excess probability of the disorder. By providing cost estimates of each effect separately in subsequent chapters, the reader can use the information as required by their risk data.

## III.2.A.3 Causality and Special Susceptibilities

As described above, LBW may result from prematurity (a pregnancy of less than 38 weeks with or without growth retardation) or from delayed growth of an infant that is full-term (38+ weeks).

### *III.2.A.3.1 Introduction*

Prematurity may result from a variety of factors, including external factors, maternal health, and the condition of the fetus. The causes in humans are difficult to evaluate through the usual animal toxicology studies because rodents are usually used in studies of reproductive outcomes. The rodent gestation period is short, and there is a small window in time when pregnancy could be observed to result in a live, but premature birth. More often the studies yield results that include miscarriage, which is a delivery prior to full-term that results in the death of the offspring. Numerous chemicals are associated with miscarriage in toxicological studies of pollutants. Many of these are listed in Table III.1-1 in Chapter III.1

*Link to Table III.1-1*

### *III.1.A.3.2 Data on Causality*

Intrauterine growth retardation (IUGR) results in infants who have retarded growth, and are born smaller and in a more immature condition than normal infants. They are often LBW infants. Among chemicals that cause reproductive disorders, it is very common to observe retarded growth as one of the effects. Retarded growth is often coupled with other effects, including structural abnormalities and functional anomalies. For example, chromium, which has been the subject of multiple developmental toxicity studies, is associated with delayed bone formation, decreased fetal size, skeletal anomalies, increased resorptions (fetal death) and postimplantation loss (embryonic loss). This cluster suggests a variety of developmental impacts, including growth retardation.

Many of the objective measures of developmental toxicity in animals are highly specific (e.g., delayed bone ossification, decreased fetal weight); however, when considered as an overall description of the condition of the offspring, they are analogous to growth retardation in humans. Developmental toxicity studies in animals usually evaluate the offspring very near the time of, but prior to, birth, and in the process they sacrifice the animals (this is why studies report “fetal” rather than “offspring” abnormalities). Consequently, animal studies provide limited predictive

information regarding the postnatal disorders associated with low birth weight in humans. Multigeneration studies and postnatal studies may be carried out, but are more expensive and so are less frequently available.

There are a very limited number of studies evaluating low birth weight and intrauterine growth retardation in humans in relation to environmental exposure. It is both difficult and expensive to carry out well-controlled human development studies. This is illustrated by a recent study by Munger et al. (1997) that found an association between herbicide-contaminated drinking water supplied in the Midwestern United States and intrauterine growth retardation. The presence of very commonly encountered pesticides (e.g., atrazine, metolachlor, and cyanazine) were linked to growth retardation after controlling for multiple potential confounders (e.g., smoking, nutritional status, alcohol consumption). Low birth weight was also marginally increased among the exposed population. As is the case for most environmental studies, exposures occurred simultaneously to the mixture of chemicals, with varying concentrations over time. Conclusions can be drawn regarding an association between the cluster of chemical and growth retardation. However, the ability to establish causality for specific chemicals in this study is questionable.

### *III.1.A.3.3 Environmental Agents of Concern*

Human data on environmental risk factors associated with LBW are very limited, but dozens of chemicals have been demonstrated to cause LBW in experimental animals, including many common pollutants. Table III.1-1 in Chapter III.1 lists some of the chemicals associated with developmental toxicity. Many of these are linked to growth retardation and/or prematurity. Many chemicals have been shown to cause LBW in experimental animals. Delayed development and reduced body weight are relatively common observations in developmental toxicity studies on chemical pollutants.

*Link to Chapter III.1, Table III.1-1*

Some chemicals associated specifically with LBW are acrylic acid, aroclor 1016 (a PCB), chlorobenzilate, captan, benomyl, cylothrin, dimethyl sulfoxide, dicamba, dinoseb, flutolanil, methyl ethyl ketone, metholchlor, napropamide, nitroguanidine, phenol, propagite, resmethrin, rotenone, vernam (IRIS), and chromium (ATSDR, 1993). LBW is also strongly associated with pre-term delivery due to substance abuse, smoking, diabetes, poor prenatal nutrition and care, and other causes.

### *II.2.A.3.4 Susceptible Subpopulations*

African-American infants are twice as likely as white infants to be born with LBW and their risk is even greater for very LBW births. The causes of this increased rate are not know. Although social and economic factor, access to medical care, and other societal issues are considered to be

responsible in part (Shiono and Behrman., 1995), very recent studies that have controlled for these factors have found an increase in LBW among African-American infants. It has been theorized that some groups may be genetically at greater risk for LBW, suggesting a sensitive subpopulation that may merit consideration in a benefits assessment. Additional support for this argument can be obtained from the literature, which indicates that the rates of LBW among other ethnic minorities in the United States (i.e., Hispanic, Native American, and Asian American) are similar to those of the white population (Paneth, 1995). Consequently, biological and genetic factors may be important considerations (Shiono and Behrman, 1995). In an environmental risk benefit context, African Americans may be considered to be at higher risk, and benefits of avoiding environmental agents that pose risks of LBW should be considered accordingly. Additional research is required in this area to fully explore the risk factors involved.

### III.2.A.4 Treatment and Services

Medical services in the neonatal period address the numerous acute medical problems described above (see "Description"). They are designed to eliminate the short-term crisis and mitigate long-term health problems. Extensive medical services are often required whether the LBW results from a preterm delivery or a IUGR condition. Treatment often includes monitoring in a neonatal intensive care unit; extensive testing to determine the functional status of various organ systems; surfactant therapy to preserve lung structure; specialized nutrition; fluid management; and management of respiration, glucose levels, temperature, and other basic physiological processes at a normal level to minimize damage (Oski, 1993).

Prenatal evaluations may provide information regarding intrauterine growth retardation (IUGR), and medical intervention may begin considerably prior to the birth of the child to address problems that have been diagnosed. The costs of these types of services are not included in the estimates provided below. They typically would be considered a part of prenatal costs and would be attributed (in most accounting methods) to the mother, rather than the child. Their lack of inclusion in this chapter generates a cost estimate that underestimates true costs by the amount spent prenatally to minimize exposure.

### III.2.A.5 Prognosis

Although mortality among LBW infants declined rapidly into the 1970s, the morbidity among the survivors has increased, due to the survival of much smaller and more seriously ill infants. Table III.2-1 shows the morbidity pattern for some major categories of illnesses arising from LBW in relation to the size of the infant at birth. It demonstrates that there is an increasing risk of morbidity and mortality associated with progressively smaller birth

weight. The table includes selected outcomes for the most seriously underweight infants, and does not include those in the moderate LBW category, defined above as having a birth weight of 1,501 to 2,500 grams.

**Table III.2-1. Morbidity and Mortality Among Very Low Birth weight Infants.**

*Based on data from the National Institute of child Health and Human Development Neonatal Network. Adapted from Oski, 1993 and originally based on Hack et al., 1991.*

| | Weight at Birth ( in grams) | | | |
|---|---|---|---|---|
| **Effect** | **501-750** | **751-1000** | **1001-1250** | **1251-1500** |
| morbidity among survivors (%) | 56 | 39 | 25 | 15 |
| chronic lung disease (%) among survivors | 26 | 14 | 7 | 3 |
| intracranial hemorrhage (%) among survivors | 26 | 17 | 13 | 6 |
| enterocolitis(%) among survivors | 3 | 8 | 6 | 4 |
| death (%) | 66 | 34 | 13 | 7 |

Although survival among LBW has improved considerably in recent years, those that survive often have long-term health and developmental problems (Oski, 1993). The long-term prognosis for LBW children depends greatly on the severity of their initial condition, as well as the medical services provided shortly after birth. Researchers have found that "Infants with IUGR secondary to environmental insult or decreased growth potential generally have outcomes that are poor and reflect the underlying neuropathology of conditions caused by the environmental or genetic insult." (Oski notes: "environmental" in this context refers to all factors outside the mother and child). Infants with normal brain growth generally have a more favorable prognosis. Most full-term IUGR infants have normal intelligence, and even many preterm IUGR infants achieve normal intelligence by school age (Oski, 1993). Conversely, children with LBW are more likely than children with normal birth weight to have attention disorders, developmental impairments, breathing problems (e.g., asthma), and learning disabilities (Shiono and Behrman, 1995). All categories of LBW children are more likely to be enrolled in special education classes than normal birth weight children, and half of all children who were very LBW are enrolled in special education classes (Hack et al., 1995).

## III.2.B Costs of Medical Treatment and Other Services

The overall costs associated with LBW infants are very high and comprise a substantial portion of all pediatric costs. While costs vary considerably depending on the individual and the severity of their condition, the costs for a single infant with LBW may exceed $1 million. The average cost for initial hospitalization (only) for surviving infants weighing 500 to 600

grams was $1 million per child (Pomerance et al., 1993). This weight group is the most seriously affected, but their costs give some indication of the potential magnitude of the medical costs. Most LBW infants require some additional care, at an increase in cost over the usual pediatric care expenditures. It has been estimated that of the $11 billion spent on health care for infants, approximately 35 percent ($4 billion ) is spent on the incremental costs of medical care for LBW infants (Lewit et al., 1995).

There are two studies of the costs of LBW discussed in this section. The Lewit et al. (1995) study, discussed in detail below, is more comprehensive and is recommended for use in cost estimates. A study by McCormick et al. (1991) is also briefly discussed, but is not recommended for use in evaluating LBW costs due to its limitations.

## III.2.B.1 Methodology

### *III.2.B.1.1 Data from Lewit et al.*

A recent comprehensive analysis of LBW was published in 1995 by Lewit et al. They analyzed the incremental direct costs of low birth weight using a prevalence approach. These costs, estimated for children aged 0 to 15, include expenditures for health care, child care, special education, and grade repetition (considered to be related to special education). Each type of cost is itemized, and although the handbook focuses on medical costs, the costs of related professional services (e.g., special education) are included in the material presented in this chapter. Child care, while a direct cost, is not estimated in other chapters of this handbook and was not included this chapter. (The study authors note that their comprehensive approach offers an opportunity to evaluate the impact of LBW in a single metric. Readers may wish to consult their work, depending on the goals of their morbidity valuation.)

Lewit et al. (1995) used a number of sources for their study. Estimates for LBW babies during the first year of life were obtained by combining data from two other studies, as well as the data from the CIGNA Corporation's national employer-based business survey. The data were obtained from a private source; the birth weight-specific cost ratios were therefore adjusted to match the actual distribution of birth weights in the 1988 U.S. birth cohort. The population-weighted relative cost ratios were applied to the estimated national expenditures for infant health care in 1988 to determine the allocation of expenditures between LBW and normal birth weight infants.

To estimate the incremental increase in costs for LBW children beyond the first year of life, the 1988 Child Health Supplement of the National Health Interview Survey and the 1991 National Household Education Survey were used. The large number of children involved in the surveys allowed for evaluation of age-specific resource utilization. Data regarding birth weight,

hospitalization costs, and other relevant data were used. Multivariate statistical analyses were conducted to control for the effects of potential confounding variables, such as income and the mother's educational level. Estimates of health care costs are also largely based on a previous study that used the 1987 National Medical Expenditure Survey (USDHHS, 1988).

The incremental costs of special education and of repeating a grade were estimated by Lewit et al. for children through the age of 15 years. Inclusion in special education classes and grade repetition both occur with greater frequency among LBW children than among non-LBW children. Although they are not a part of medical costs, they are included as supplemental information and may be considered to be a part of special services related to a medical condition.

The Lewit et al. (1995) analysis of children's medical costs after the first year of life includes *only* the hospital and medical fees associated with hospitalization. They evaluated the different hospitalization rates for LBW and non-LBW children and used this ratio, with the average annual hospital costs per child for all children, to estimate the incremental annual hospitalization costs for LBW children. This approach will underestimate total medical costs because it does not include office visits, pharmaceuticals, therapy, and other medical services that are not a part of a hospitalization incident. For example, annual medical costs for asthmatic children may be high, even when they are not admitted to the hospital. (Chapter IV.2 contains a discussion of costs associated with asthma.) LBW children have an increased rate of asthma occurrence and would be expected to have this type of non-hospitalization cost. This cost is not included in the Lewit cost estimate because it is not a hospitalization cost. There are likely to be many other medical services required for LBW children that do not require hospitalization; the costs of services were not calculated by Lewit et al.

*Link to Chapter IV.2*

This handbook addressed the lack of cost data for medical services unrelated to an inpatient visit (hospital stay) for children over the age of one by applying an inpatient/outpatient factor obtained from another study to estimate the costs of outpatient services. A number of data sources were considered for this factor, including data obtained from costs of treating birth defects (Waitzman et al., 1996 data as discussed in Chapters III.3 through III.8) and the Health Care Financing Administration (HCFA) data. A prominent consideration in selecting the source of the factor was the anticipated medical services required for LBW children after the age of one year. It was assumed that much of the care would be for chronic health problems and that surgical intervention would be minimal. These assumptions would lead to an allocation of services more heavily weighted

toward outpatient care than would be the case for treatment of diseases that require substantial surgical intervention, such as treatment of many of the birth defects discussed in Chapters III.1 through III.8 of this handbook. Consequently, costs from those chapters were not considered optimal. Likewise, the HCFA data, which includes surgical and other acute care as a major component, was not considered appropriate for establishing the ratio for chronic care treatment of LBW children.

Due to its focus on chronic care after initial diagnosis, cost data for the treatment of asthma, discussed in Chapter IV.2 of this handbook, was selected as having the most analogous type of care and cost requirement to the chronic care provided for LBW children. The inpatient/outpatient cost ratio can be calculated from the data provided in Chapter IV.2. The costs for young children (ages 4 to 5) shown in Table IV.2-15 were used to estimate the ratio. The sum of the office visit, drug therapy and emergency room costs is $605.37 per year, and the hospitalization cost is $105.79 per year. The outpatient/inpatient ratio was calculated to be 5.72. This value was used to estimate the outpatient costs for LBW children by multiplying the inpatient costs times 5.72. This value is a source of considerable uncertainty in the cost estimate. However, it was felt that it would be better to provide an estimate than to omit the costs for outpatient care altogether.

*Link to Chapter IV.2, Table IV.2-15*

Additional data will be sought on this issue and the value may be updated in the future. Results obtained from application of this factor are shown in the "Results" section below.

### *III.2.B.1.2 Supplementary Cost Estimates*

Lewit et al. (1995) did not estimate incremental medical costs for ages 1 to 2 years and for children over 11 years of age. An estimate of the costs for the missing years was made for this handbook, to provide a more comprehensive estimate. Costs were estimated for the missing years as follows:

**1 -2 years.** To estimate costs for this age group, the two closest age groups were considered as sources of information. It was assumed that the medical and related costs of LBW are highest in infancy, and that these costs should drop off quite quickly after the first year of life. Consequently, the incremental cost during the first year of life, of approximately $25,000, was not considered an appropriate data source. The cost per year for three- to five-year-olds was assumed to be the most representative of the one- to two-year age group, although some of the substantial medical costs seen in infancy may persist into this age group for those children most seriously affected (i.e., the very low birth weight infants). Despite this drawback, the three- to five-year-olds' cost per year

was assumed to be the best option for the estimate and was used for ages one and two.

**11 - 15 years**. Although incremental educational costs were estimated for this group by Lewit et al., the researchers did not estimate the costs for medical services for this age group. The costs were extrapolated from the costs per year for six- to ten-year-olds because it was assumed that the medical costs would be very similar. LBW children often have health problems (as noted in Section II.2.A, above) that are chronic and continue through the life of the individual (Lewit et al., 1995). For example, Section II.2.A noted that LBW children are more likely to have neurological damage, asthma, and gastrointestinal disorders. These disorders are not age-limited. Although many very serious acute health problems related to LBW are addressed in the first year of life, those that persist into school age are chronic health problems that are likely to recur over the lifetime of the individual. Consequently, the increased costs seen during childhood in the post-acute treatment period (e.g., ages five to ten years) are a reasonable estimate of the costs that may be incurred later in childhood, as well as in adulthood (see below).

**15 - 75 years.** LBW children have higher hospitalization rates and require more medical services in both the preschool- and school-age years than non-LBW children (Corman and Chaikind, 1993; Corman, 1994). Due to the inability to track many children over the age of 15 years (as a result of their dropping out of school, etc.) and corresponding lack of good tracking data, the analysis was not conducted on children over the age of 15 by Lewit et al. Increased medical and related costs are likely to continue for these individuals, due to persistent medical and, in some cases, social and educational costs. To address this factor, an estimate was made of the potential lifetime incremental medical costs of LBW, assuming that the increased yearly costs seen in the six- to ten-year-old age cohort would be representative of the costs over a lifetime. As noted above, in all cases the cost data are for increased rates of hospitalization only and do not include outpatient services, long-term care facilities, pharmaceuticals, etc. The values are underestimates of the actual total incremental medical costs associated with LBW.

## III.2.B.2 Results

This section contains both comparative information regarding the costs for LBW infants versus normal weight infants, and costs associated with LBW over the childhood years.

### *III.2.B.2.1 Aggregated First-Year Costs for All Infants*

Table III.2-2 shows the total and incremental costs for LBW infants during the first year of life, in contrast with normal birth weight infants. The LBW costs, based on 1988 data from Lewit et al. (1995), are weighted averages

based on the costs for all LBW categories and the proportion of infants in those categories. The costs are updated using the Consumer Price Index (CPI) for medical care from 1988 to 1996 dollars (1996:1988=1.6465). The total costs and costs for all births and normal weight infants are provided for comparative purposes.

**Table III.2-2. Comparative Medical Costs for LBW and Normal Birth Weight Infants During the First Year of Life in 1996 Dollars.**

| Birth Weight Group (in grams) | Number of Births in 1988 in the U.S. | Incremental Cost per Child in 1996 Dollars (1st year) | Total Costs in 1996 Dollars (billions) | Percentage of Total Health Care Costs for Infants |
|---|---|---|---|---|
| all births | 3,871,000 | 3,128 | 12.2 | 100% |
| normal weight (2,500+) | 3,600,000 | 1,554 | 5.6 | 65% |
| LBW[a] (<2500) | 271,000 | 24697 | 6.6 | 35% |
| extremely LBW (<1,000) or having respiratory distress syndrome | 57,000 | 52,688 | 3.0 | 16% |
| other LBW (1,000 -2500 without respiratory distress syndrome) | 214,000 | 16,465 | 3.6 | 19% |

Source: Lewit et al., 1995 adjusted for inflation using CPI (1996:1988=1.6465)
a. Average for all LBW infants.

### *III.2.B.2.2 Annual Per Capita Costs for LBW Infants*

Table III.2-3 shows the incremental direct costs per year estimated by Lewit et al. (1995) for each age group for the average LBW infant. It also shows outpatient cost estimates derived in this handbook from the ratio of outpatient to inpatient costs (see methodology section for detail).

As noted above, Lewit et al. (1995) estimated health care costs for ages through ten years only and did not estimate any costs for ages 1 and 2 years. As noted above, these gaps were addressed by using costs for the 3 to 5 year old age group as representative of the costs for ages 1 and 2 years. In addition, the medical costs for the 11 to 15 year olds and the 16 to 75 year olds were extrapolated from the costs per year for 6 to 10 year olds.

| Table III.2-3. Annual Incremental direct costs per LBW child (1996$) | | | |
|---|---|---|---|
| **Age Group** | **Cost Type** | **Mean Cost per Year per LBW Child** | **Outpatient Cost Estimate Based on Ratio[3]** |
| Infancy | Health Care (all medical costs) | $24,697[1] | (not calculated separately ) |
| 1 to 2 years | Health Care (inpatient only) | $477[2] | $2,728 |
| 3 to 5 years | Health Care (inpatient only) | $477[1] | $2,728 |
| 6 to 10 years | Health Care (inpatient only) | $774[1] | $4,427 |
| 6 to 15 years | Special Education | $247[1] | N/A |
| 11 to 15 years | Health Care (inpatient only) | $774[2] | $4,427 |
| 11 to 15 years | Grade Repetition | $74[2] | N/A |
| 16 to 75 years | Health Care (inpatient only) | $774[2] | $4,427 |

[1] Costs from Lewit et al. (1995), adjusted for inflation, as shown in Table III.2-2.

[2] Costs based on Lewit et al., estimated and modified as discussed in the Methods section of this chapter.

[3] Outpatient costs were estimated based on an outpatient/inpatient ratio derived from treatment of asthma patients. See Methods section of text for discussion.

Lewit et al. estimated that there were approximately four million LBW children from ages birth to 15 years in 1988 and that their total incremental direct costs were $5.4 trillion in 1988 dollars. Using the Consumer Price Index (CPI) for medical care from 1988 to 1996 dollars (1996:1988=1.6465), the total cost in 1996 dollars (assuming a population the same size as in 1988) is $8.91 billion.

### *III.2.B.2.3 Childhood Costs*

The direct medical costs for ages 0 to 15 years are shown in Table III.2-4 at four discount rates (zero, three, five, and seven percent). These are average values; as Table III.2-2 demonstrated, the costs are much higher for some children, born with extreme low birth weight and/or respiratory distress.

*Link to Table III.2-2*

The total estimated cost for special education, grade repetition, and medical care (as itemized in Table III.2-3) for ages 0 to 15 years is $85,447 (undiscounted in 1996$).

| Table III.2-4: Discounted childhood medical care costs (Age 0-15) for Low Birth Weight in 1996$ | | | | |
|---|---|---|---|---|
| | **0%** | **3%** | **5%** | **7%** |
| **Inpatient and Estimated Outpatient Medical Care** | $82,607 | $69,765 | $63,292 | $58,052 |

### *III.2.B.2.4 Lifetime Costs*

Medical and other costs for LBW individuals persist into adulthood. They often have health problems (as noted in Section III.2.A, above) that are chronic and continue through the life of the individual. To address this factor, an estimate was made of the potential lifetime incremental medical costs of LBW, as described in Section III.2.B.1, above. Table III.2-5 below provides an estimate of lifetime incremental medical costs that may be incurred.

In reality, it is most likely that those individuals most seriously affected by LBW will have substantially increased medical costs that exceed the estimate given below (e.g., those with serious brain damage, respiratory insufficiency), and that many individuals with moderate LBW will have minimal incremental costs associated with their birth condition. The values below are an estimate of the likely average costs that may be incurred.

*Link to Section III.2.B.1*

The total estimated cost for special education, grade repetition, and medical care (as itemized in Table III.2-3) is $436,514 for a full lifetime of 75 years (undiscounted in 1996$).

| Table III.2-5: Discounted lifetime medical costs (Age 0-75) for Low Birth Weight in 1996$ | | | | |
|---|---|---|---|---|
| | **0%** | **3%** | **5%** | **7%** |
| **Inpatient and Estimated Outpatient Medical Care** | $348,227 | $148,406 | $103,601 | $80,578 |

### *III.2.B.2.5 Limitations*

The data provided in the Lewit et al. (1995) study have several limitations, discussed briefly below, with regard to determining average costs.

The data used by Lewit et al. had very few observations of very low birth weight children. The cost estimates may be underestimated because very LBW children incur the highest costs.

The authors noted that the costs may be underestimated due to limited access to data on charges in the neonatal intensive care unit (NICU, where the most significant charges are incurred) and on subsequent hospital stays.

The data used by Lewit et al. were from one geographic area. There are likely to be some regional differences in practices and costs.

Some aspects of the cost estimate relied on parental surveys, which introduce uncertainty.

Data regarding some age groups are lacking. Best estimates of the costs for age cohorts 11 to 15 years and 16 to 75 years were made based on reasonable use of the existing data. Actual cost data would be preferable. The lack of data for the one to two years age group is particularly problematic. Because the one- and two-year-old child is still very close in age to the birth experience and attendant medical problems, they are more likely to require continuing medical and developmental services than they would in at ages three to five. The three- to five-year age group was the source of the cost data extrapolated to the one to two year age group. The costs for the three- to five-year-olds are likely to underestimate the medical costs for the 1 to 2 year age group, especially among the very low birth weight children.

Finally, the most serious limitation is the lack of data, aside from hospitalization costs, on non-hospital costs after the first year of life. Hospitalization costs are clearly a significant factor in lifetime costs, but they underestimate the total incremental medical costs by a factor that is unknown. This uncertainty is offset partly by the comprehensive medical costing that was carried out for the first year of life by Lewit et al. The first year is the most expensive for LBW individuals, especially for those with the most costly medical treatment. Accurate accounting during this critical period provides a good basis for the overall cost estimate for LBW. The outpatient cost estimates based on the experience of asthmatics provides a reasonable estimate of outpatient costs for LBW individuals after the first year of life. The lack of comprehensive medical cost data for latter years introduces additional uncertainty into the cost estimate and will result in an underestimate of total costs.

As with all cost estimates in this handbook, changes in technology create uncertainty regarding the costs and practices that are currently relevant.

### III.2.B.3 Other Studies

McCormick et al. (1991) provides another estimate of LBW costs, but only for the first year of life. The researchers analyzed the costs incurred by parents of Very low birth weight babies after the initial neonatal hospitalization. Costs were obtained from a study of Very low birth weight infants discharged from the Infant Intensive Care Unit of the Children's Hospital of Philadelphia from July 1983 to October 1984. The study population consisted of 32 infants. Incremental costs were evaluated using

control group of 34 infants born with normal birth weight. Costs were estimated only for the first year of life and obtained solely for the one hospital's birth cohort.

The costs incurred by the family after leaving the NICU were recorded and include hospital care, visits to doctors, diagnostic tests, prescription and nonprescription medication, medical supplies and equipment, and special infant formulas. Other costs reported by McCormack et al. are: hotel charges associated with rehospitalization, renovations to the house, special diets, travel to obtain health care, and the cost of in-home care or day care. While important , they are not discussed in this chapter, since they do not fall within the scope of the handbook.

Total per capita direct costs estimated by McCormick et al., over the first year are presented in Table III.2-6. The estimates are updated from 1984 to 1996 dollars using the Consumer Price Index for medical costs (1996:1984=2.14). The costs were calculated after subtracting the costs for medical care for the control group (the non-LBW children) to obtain incremental costs of LBW.

**Table III.2-6: First year medical costs for LBW infants in 1996$ (McCormick et al., 1991)**

| Type of Costs | Total Year |
|---|---|
| Hospital Care | $15,705 |
| Physician Visits | $709 |
| Other Direct Medical Expenditures | $2,667 |
| **Total** | **$19,145** |

The costs presented in this chapter were current in the year the chapter was written. They can be updated using inflation factors accessible by clicking below

*Link to inflation factors*

Additional studies conducted in the 1980s provide some information on this topic (OTA, 1988; Boyle et al., 1983). These studies, however, have several drawbacks. They do not provide complete cost estimates, use data that are not well-suited to this analysis (either Canadian costs, or costs primarily for moderate LBW rather than including very or extremely LBW infants), and the ages of the studies are not optimal, due to rapidly changing medical practices in this field. Additional studies are available on specific population groups, but do not provide representative data on costs (Hack et al., 1995).

### III.2.B.4 Conclusions

The Lewit et al. (1995) study is the most comprehensive and uses a number of credible databases and assumptions to derive incremental cost estimates. In addition, costs were extrapolated for ages not covered by the Lewit et al. study; these extrapolations were reasonable and provide an estimate of average costs. The incremental costs for very LBW and extremely LBW infants are likely to be much higher throughout their lifetime due to persistent serious medical conditions. The McCormick et al. study looks only at the first year of life, while the Lewit et al., (1995) study estimates health care costs over the first ten years, and other costs up to age 15. Because of this restriction, cost estimates based on the Lewit et al. results are recommended for use in LBW valuation. As discussed in the "limitations" section above, the Lewit et al. data are likely to underestimate the actual incremental medical costs for LBW.